The duration-specific peak average running speeds of European Super League Academy rugby league match-play

Running head: Peak average running speeds of Academy rugby league

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ABSTRACT

This study aimed to quantify the duration-specific peak average running speeds of Academy level rugby league match-play, and compare between playing positions. Global Positioning System data were collected from 149 players competing across nine teams during 21 professional Academy (under-19) matches. Players were split into six positions: hookers (*n* = 40), fullbacks (*n* = 24), halves (*n* = 47), outside backs (*n* = 104), middles (*n* = 118) and backrow forwards (*n* = 104). Data were extracted and the10-Hz raw velocity files exported to determine the peak average running speeds, via moving averages of speed ($m \cdot min^{-1}$), for 10- and 30-seconds, and 1- to 5- and 10-minute durations. The data were log transformed and analysed using linear mixed effect models followed by magnitude-based inferences, to determine differences between positions. Differences in the peak average running speeds are present between positions, indicating the need for position specific prescription of velocity based training. Fullbacks perform *possibly* to *most likely* greater average running speeds than all other positions, at each duration, except at 10-seconds *vs.* outside backs. Other differences are duration dependent. For 10-seconds the average running speed is *most likely* greater for outside backs *vs.* the hookers, middle and backrow forwards, but *likely* to *most likely* lower for 10-minutes. Hookers have *possibly* trivial or lower average speed for 10-seconds *vs.* middle and backrow forwards, but *very likely* greater average running speed for 10-minutes. The identified peak average running speeds of Academy level match-play appear similar to previously reported values of senior professional level.

Key words: Global positioning systems, match-demands, youth, locomotor demands, team sports

INTRODUCTION

Rugby league is an intermittent contact sport involving periods of high-intensity activity (i.e., tackling, high-speed running), interspersed with periods of low-intensity activity (i.e., walking, jogging) (12, 15). It is played internationally by junior and senior players, from amateur to elite professional standards (15), predominantly within the United Kingdom (UK) and Australasia. Within the UK, the playing pathway to develop players to compete in the European Super League (ESL) is through academies, aligned to professional ESL clubs (23). The academy system consists of an Under 16-year (U16) age group 'Scholarship', who play a small number of matches per year for the ESL club, while also still training and playing for their amateur team. Players identified as having ESL potential are then recruited into an U19 'Academy' team and sign professional contracts (e.g., do not train or compete with other teams). The Academy level is prior to senior ESL, thus the training and match exposure during the U19 Academy competition is imperative to preparing young players for senior professional rugby league (23).

Research to date has investigated the whole- and half-match demands of rugby league for positional groups (i.e., forwards and backs) (19), and specific positions (i.e., fullbacks, outside backs, halves, hooker, edge-, and middle-forwards) (5), across different competitions (i.e., age and level) (12, 15). Higher standards of competition are suggested to have greater running demands (12), with senior professional players covering greater total and high speed running distances during match-play than junior elite players in Australia (19). Recent research within junior levels (e.g., U16), found International forwards cover greater distances at sprint (> 7 $m \cdot s^{-1}$) speed, achieve greater maximum velocities, and exhibit greater peak average speeds over a range of duration-specific periods than Club forwards (31). Whereas International backs were found to have lower average match speeds, cover less distance at sprint speed and exhibited lower peak average speeds over short durations than Club backs (31). These finding highlights how different positional groups have unique exposures at different levels, thus it is important that future research investigates the running demands of players by playing position, rather than positional groups, to ensure these unique differences are captured (31).

The ‘intensity’ of a match is typically quantified by the average speed over a specified duration, usually expressed as relative distance (i.e., total distance covered relative to time; $m \cdot min^{-1}$) (2), via global positioning system (GPS) processors housed within micro-technology units. Previous match demands research has typically been based on the whole- or half-match (8, 28), which considering the intermittent nature of sport, provides a blunt measure of the movement demands (e.g., intensity), and likely misses the important, ‘intense’ periods of play (11). It is now acknowledged that the identification of ‘peak’ match demands are an important part of understanding how practitioners should prepare athletes for competition (6, 14, 16). By quantifying shorter duration periods of match-play (e.g., 5-minute peak ~111 to 126 $m \cdot min^{-1}$) (5, 14) average speeds typically exceed whole- and half-game averages (82 to 105 $m \cdot min^{-1}$) (8, 26). To determine these peak periods of play, the moving average method of analysis appears the most effective (27, 32), due to its ability to capture the subtle fluctuations in running intensity (27).

The duration-specific peak running demands of rugby league match-play have received significant attention at the senior professional level (5, 6, 29). Peak average running speeds range from ~154 to 179, and ~90 to 109 $m \cdot min^{-1}$ for 1-, and 10-minute periods respectively, during Australasian National Rugby League (NRL) (5, 6) and ESL match-play (29). Within specific positions, fullbacks, halves and hookers have higher peak average running speeds compared to outside backs, edge forwards, and middle forwards across all durations investigated (1 to 10 minutes) (5). Within junior rugby league, Kempton and colleagues (16) identified the peak 5-minute average running speed of match-play in the National Youth Cup (NYC), an elite under-20s competition in Australia, to be ~120 $m \cdot min^{-1}$, with no significant difference to NRL match-play. However, this study is limited by the inclusion of only one NYC club, reducing the generalizability of these findings, and the ability to explore position specific, as opposed to positional group differences. The inclusion of data from only one club appears a common limitation within this area (see Whitehead et al., 2018) (32).

To address the limitations of small samples, and therefore lack of positional data it is important that studies recruit multiple teams. Furthermore, while the peak average running speeds of English U16, and Senior ESL players have been quantified, a key omission is the U19 Academy competition, which is arguably the most important level to ensure players are exposed to the appropriate running speeds that will aid in preparing players to successfully progress to the ESL level. Therefore, the purpose of this study was to quantify the duration specific peak average running speeds of Academy level match-play and compare between playing positions. By using multiple-clubs we aim to overcome the limitation of one-club studies, providing practitioners and coaches with values that are representative of the Academy level competition, and provide position specific peak intensities to aid in appropriate training prescription.

METHODS

Experimental approach to the problem

A prospective observational study design was used to establish the duration-specific peak average running speeds of Academy-level rugby league match-play. GPS data were collected from competitive match-play of nine professional rugby league clubs competing in the ESL Under 19s Academy Championship during the 2017 season. The peak average running speeds of specific positions were quantified and compared.

Subjects

One-hundred forty-nine male rugby league players (age 17.1 ± 1.0 years, body mass 88.4 ± 12.3 kg, height 179.2 ± 6.1 cm) from nine Under 19 Academy teams participated. GPS data from 21 matches totaling 391 match observations were collected, with both home team and opposition data collected during 5 matches and dealt with using the appropriate statistical analysis. The mean (± standard deviation [SD]) observations per player was 2.3 ± 3.0 (range: 1 to 16). Players were split into six playing positions, (5, 6); fullbacks (number of observations per positional group [*n*] = 24), hookers (*n* = 40), halves (*n* = 47), outside backs (*n* = 104), backrow forwards (*n* = 58), and middle forwards (*n* = 118). The study was approved by Leeds Beckett University Human Ethics Committee. Prior to the

commencement of the study, all participants were informed on the purpose, benefits and requirements of the study, and written consent was obtained from player. Parental or guardian informed consent was obtained for subjects under the age of 18 years.

Procedures

Micro-technology units (Optimeye S5, Catapult Innovations, Melbourne, Victoria), with a GPS receiver sampling at 10-Hz (firmware version 5.27), were used to assess the match demands. Ten-Hz GPS devices are deemed as reliable and valid to quantify distance and speed measurements in team sports (22). Appropriate preparation of the units was carried out; players wore the units in tight fitted garments with the device positioned between their scapulae, devices were switched on 30-minutes prior to the commencement of match-play to ensure sufficient satellite connection and players wore the same units for repeated observations (18). The number of satellites and HDOP during match-play was 12.2 ± 2.1 (range: 8 to 15) and 0.9 ± 0.1 (range: 0.7 to 1.1) respectively; both considered acceptable for GPS data collection (18).

Following the completion of each match, data were extracted and analyzed using propriety software Openfield (v1.14, Catapult Innovatons, Melbourne, Victoria). Speed was calculated via the Doppler shift method. The raw instantaneous speed data were exported then analyzed in R (v R-3.1.3, R Foundation for Statistical Computing, Vienna, Austria). A custom-built algorithm using the *zoo* package (33) was used to compute moving averages of the speed ($m \cdot min^{-1}$), over eight different durations: 10- and 30-seconds, and 1-, 2-, 3-, 4-, 5- and 10-minutes. The maximum value for each player, for each duration, per match, was determined then averaged for the specified position for between-group comparisons. The minimum and maximum of values for every duration achieved by each position, across all matches, was also determined.

Statistical analysis

Data were log-transformed prior to analyses to reduce bias and non-uniform error (13). Descriptive data are presented as mean ± SD. Linear mixed-effects models were carried out in SAS Studio

Software (4.2, SAS Institute Inc., Cary, NC, USA) to assess differences in the duration-specific peak periods between positions. Individual athletes and game identification were included as random effects to account for repeated measures (5) and variability between matches (17). Positions were included as fixed effects to describe their relationship with the dependent variable. Pairwise comparisons between positions were assessed using the Least Squares mean test. Differences of Least Squares means were back-transformed to percentage differences, with 90% confidence intervals (CI). Standardized differences (Effect size; ES) were quantified (with 90% CI) and classified as *trivial* (<0.2), *small* (0.2 - 0.59), *moderate* (0.6-1.19), *large* (1.2-1.99), *very large* (2.0-4.0), or *extremely large* (>4.0) (13). The practical importance of the derived differences were determined using the magnitude-based inference network (1). The smallest worthwhile difference (SWD) was calculated as 0.2 x the between subject SD and assessed qualitatively as: 25-75%, *possibly*; 75-95% *likely*, 95-99.5%, *very likely* and >99.5%, *most likely* (1). The magnitude was deemed *unclear* if the 90% CI over-lapped positive and negative values of the SWD.

RESULTS

The average, and range, in the duration-specific peak average running speeds for each position are shown in Table 1. The standardised differences between positions are shown in Figure 1 for 10- and 30-seconds, and Figure 2 for 1-, 5- and 10-mintutes.

INSERT TABLE 1, FIGURE 1 AND 2 NEAR HERE

Differences in the peak average running speeds were found between positions at each duration (Figure 1 and 2). Fullbacks achieve the greatest peak average running speeds for each duration investigated, with the greatest differences compared to the middle forwards at all durations (% difference [90% CI range] at 10-seconds: 19 [12 to 26]%, 1-minute: 7 [3 to 11]%, and 10-mintues: 8 [5 to 12]%). Differences between outside backs and the forward positional groups are duration dependent. For 10-seconds the peak average running speed for outside backs is *most likely* greater compared to hookers (% difference: 13 [9 to 17]%), middle forwards (15 [12 to 18]%), and backrow forwards (9 [5 to

13]%). Contrastingly, for 10-minutes, the peak average running speeds for outside backs are *most likely* lower compared to hookers (% difference: -8 [-12 to -5]%), and *likely* lower compared to middle (-3 [-5 to -1] %) and back row forwards (-3 [-6 to -1]%). Similarly, the peak average running speed for hookers is *very likely* greater *vs.* backrow forwards (5 [1 to 8]%) for 10-minutes, but *possibly* lower for 10-seconds (-4 [-10 to 2]%).

DISCUSSION

To our knowledge, this is the first study in rugby league to quantify, and compare, the positional differences in duration specific peak average running speeds during professional ESL Academy level match-play. The aim was to provide practitioners with generalisable data from multiple clubs, which can be used to prescribe and monitor running based training intensities. In agreement with previous research at the senior level (5, 6), the findings show substantial differences in the peak average running speeds between positions. Furthermore, the identified duration specific peak average running speeds of Academy level match-play appear similar to the peak average speeds reported for the senior professional level (5, 6, 29).

The peak average running speeds of Academy level match-play are position specific, likely due to both contextual factors and differences in the physical qualities between positions (7, 25). Duthie et al (7) found the peak average speeds achieved, and maintained, during rugby league competition were influenced by both high-speed running ability and prolonged intermittent running performance. Specifically, players with greater maximal running speed could generate higher peak average running speeds over short durations (7). Therefore, the higher average running speeds of outside backs for the shorter durations compared to the forward positional groups (hooker, middle forwards and backrow forwards) may be due to backs being quicker than the forward groups (25) and/or the contextual demands of the position (e.g., their tactical responsibilities in the kick chase and kick return, and more open space being available) (10) allowing more opportunities for them to express greater speed during match-play. Contrastingly, for the longer peak durations of 5- and 10-minutes, the average speeds are higher for the forward positional groups compared to the outside backs. Again, this could be related to

backs being faster (faster athletes have demonstrated a greater decline in peak average running speeds as the moving average duration increases (7)), or related to greater game involvement from the forwards, due to most of the game being played through the middle of the field. Fullbacks had the greatest peak average running speeds across all durations, likely due to their position specific tactical demands (e.g., the constant repositioning to support offensive and defensive play, meaning more field coverage is required) (10), in addition to differences in their physical qualities (e.g., lower body mass compared to middles and back row forwards) (20). Whilst these findings indicate the need for position-specific training drills, it must be acknowledged that although the differences are statistically meaningful (based on the predetermined SWD), it is currently unknown what minimal difference in speed or distance is practically meaningful. Therefore, practitioners should make their own inferences from the differences identified in the current study to create position-specific conditioning and training drills, incorporating the maximum peak running intensities identified (Table 1). Through the use of real-time feedback training drills can be manipulated to ensure the identified intensities are reached and maintained for the specified epoch (30).

For players to progress through the playing pathway and compete at a higher standard they must be optimally prepared for the increased physical, tactical and skill demands of match-play (8, 9, 16). Despite being U19, the Academy competition is the feeder competition for the ESL, therefore it is important to consider whether the peak average running speeds of match-play at this level are appropriate in preparing players for the progression. The peak average speeds identified for Academy level match-play in the current study are comparable to that of ESL (29) and NRL match-play (5, 6). One-minute peak average running speeds of ~159 to 179 $m \cdot min^{-1}$ have been reported during ESL and NRL match-play across positions (5, 6, 29), compared to ~164 to 178 $m \cdot min^{-1}$ in the current study. Similarly, the peak average speeds for 10-minutes at the Academy level range from ~94 to 106 $m \cdot min^{-1}$, which is within the ranges reported for NRL and ESL (~90 to 109 $m \cdot min^{-1}$) (5, 6, 29). The similar peak average running speeds suggest that the Academy level competition is sufficient in exposing players to the peak running speeds encountered at the senior professional level. Still, practitioners should take into account that as players progress to Super League level, their body mass

is likely to increase (24) and thus although the peak running demands appear similar, the 'fitness' requirements for running at the same speed may be higher (3).

While this study provides useful and practical data, it is important to consider that the average running speeds do not represent all of the physical demands encountered during these peak periods of rugby league match-play (29). Previous research has identified positional differences in the acceleration/deceleration demands during NRL match-play (4), given this and the metabolic cost of these actions (21), the lack of quantification of the accelerations and decelerations is a limitation of the current study. Additionally, differences in the collision demands between levels have been identified (8), hence despite the peak average running speeds being similar between Academy level match-play and senior level (ESL and NRL) (5, 6, 29), the number and intensity of collisions encountered during these periods may differ. The lack of quantification of collisions during the peak running demands is a limitation of the current study and further research is required to distinguish differences in both the running and collision demands between levels of play, and identify more in-depth differences between positions. Also, given the structure of rugby league (i.e., six tackles, 10 m retreats, 80 minutes), the rules may dictate the pace of the game, regardless of level, and players of a higher standard might simply have a lower internal response to the external demands. Furthermore, the differences in technical/tactical capabilities of the players during these peak periods is unknown; for example, considering differences in skill execution between the levels (16), it could be that the higher levels are able to execute skills and decision making better during and around these peak periods, thus having more 'impact' on the game.

The present study provides generalisable position specific peak average running speeds of English Academy level match-play for a range of durations. Differences in the peak average running speeds between positions are present, with the largest differences at 10-second and 10-minute durations, signifying the need for position specific training prescription. The peak average speeds reported for NRL and ESL match-play (5, 6, 29) appear similar to those reported in the current study, suggesting the Academy level match-play is appropriate for preparing players for the running speeds of match-

play at the higher levels. However, whilst the peak average running speeds at the Academy level appear appropriate, the overall physical demands of these periods are still unknown. Further research with the inclusion of collisions is required to determine the true peak physical demands of match-play, and differences between levels.

PRACTICAL APPLICATIONS

- The duration-specific average running speeds can be used by coaches to prepare players for the peak periods of match-play. The average running speeds of the longer durations (i.e., 5- and 10-minutes) should be used to monitor the intensity of coach led technical-tactical training games and/or drills. Using real-time feedback, drills can be manipulated to ensure the appropriate average speeds are reached and maintained. The short duration (i.e., 10-, 30-seconds, and 1-minute) average speeds can be used to prescribe and/or monitor game-specific conditioning drills with repeated exposure at or above the identified speeds.
- The current findings indicate that the prescription of peak average running speeds need to be position specific. Fullbacks require exposure to greater speeds for both short and long durations to prepare them for the running requirements of that position. For the forward positions (hooker, middle and back row forwards) there should be more focus on the average speed of longer peak running periods (i.e., 5- and 10-minutes). Whereas for the outside backs position specific short duration drills, such as attacking/defending a kick-chase at or above the identified speeds, could be targeted.
- Players competing in Academy level match-play are exposed to similar peak average running speeds to the senior professional level. Therefore, for players progressing through development pathway coaches and practitioners could focus on developing other physical, technical or tactical qualities.

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Figure 1. Standardized differences (with 90% confidence intervals) of peak average running speed between positional groups at A: 10-seconds; and B: 30-seconds. Grey zone represents trivial differences (-0.2 to 0.2 standardized difference). * = possibly, ** = likely, *** = very likely, **** = most likely.

FB = fullbacks, OB = outside backs, Ha = halves, Ho = hookers, MF = middle forwards, BR = back row forwards.

Figure 2. Standardized differences (with 90% confidence intervals) of peak average running speed between positional groups at A: 1-minute, B: 5-minutes and C: 10-minutes. Grey zone represents trivial differences (-0.2 to 0.2 standardized difference). * = possibly, ** = likely, *** = very likely, **** = most likely.

FB = fullbacks, OB = outside backs, Ha = halves, Ho = hookers, MF = middle forwards, BR = back row forwards.

Table 1. Average (± standard deviation) and range of the peak average running speeds ($m \cdot min^{-1}$) for each positional group during Academy level rugby league match-play.

Duration	Fullbacks ($m \cdot min^{-1}$)		Outside backs ($m \cdot min^{-1}$)		Halves ($m \cdot min^{-1}$)		Hookers ($m \cdot min^{-1}$)		Middle forwards ($m \cdot min^{-1}$)		Backrow forwards ($m \cdot min^{-1}$)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
10-seconds	368 ± 39	320 to 475	363 ± 54	273 to 515	350 ± 44	227 to 450	314 ± 41	236 to 421	311 ± 35	218 to 416	330 ± 44	259 to 470
30-seconds	228 ± 27	179 to 282	212 ± 22	173 to 288	208 ± 20	157 to 253	199 ± 16	160 to 233	203 ± 19	160 to 262	208 ± 20	148 to 254
1-minute	178 ± 16	152 to 210	167 ± 14	137 to 216	165 ± 14	134 to 201	164 ± 13	141 to 209	168 ± 14	112 to 190	166 ± 14	122 to 197
2-minutes	140 ± 12	118 to 173	135 ± 10	107 to 166	138 ± 11	105 to 162	134 ± 9	120 to 168	135 ± 11	100 to 160	135 ± 10	107 to 156
3-minutes	128 ± 13	105 to 163	121 ± 11	89 to 149	125 ± 9	104 to 141	123 ± 11	104 to 157	122 ± 11	87 to 146	124 ± 11	100 to 144
4-minutes	122 ± 11	103 to 148	111 ± 10	87 to 133	117 ± 9	95 to 139	115 ± 9	103 to 145	114 ± 9	88 to 132	115 ± 11	92 to 138
5-minutes	117 ± 10	101 to 140	106 ± 9	86 to 133	112 ± 9	95 to 133	111 ± 9	97 to 141	109 ± 8	89 to 129	109 ± 10	86 to 135
10-minutes	106 ± 9	89 to 127	94 ± 8	75 to 122	101 ± 10	70 to 120	100 ± 7	84 to 119	98 ± 7	79 to 115	98 ± 8	80 to 118

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Figure 1

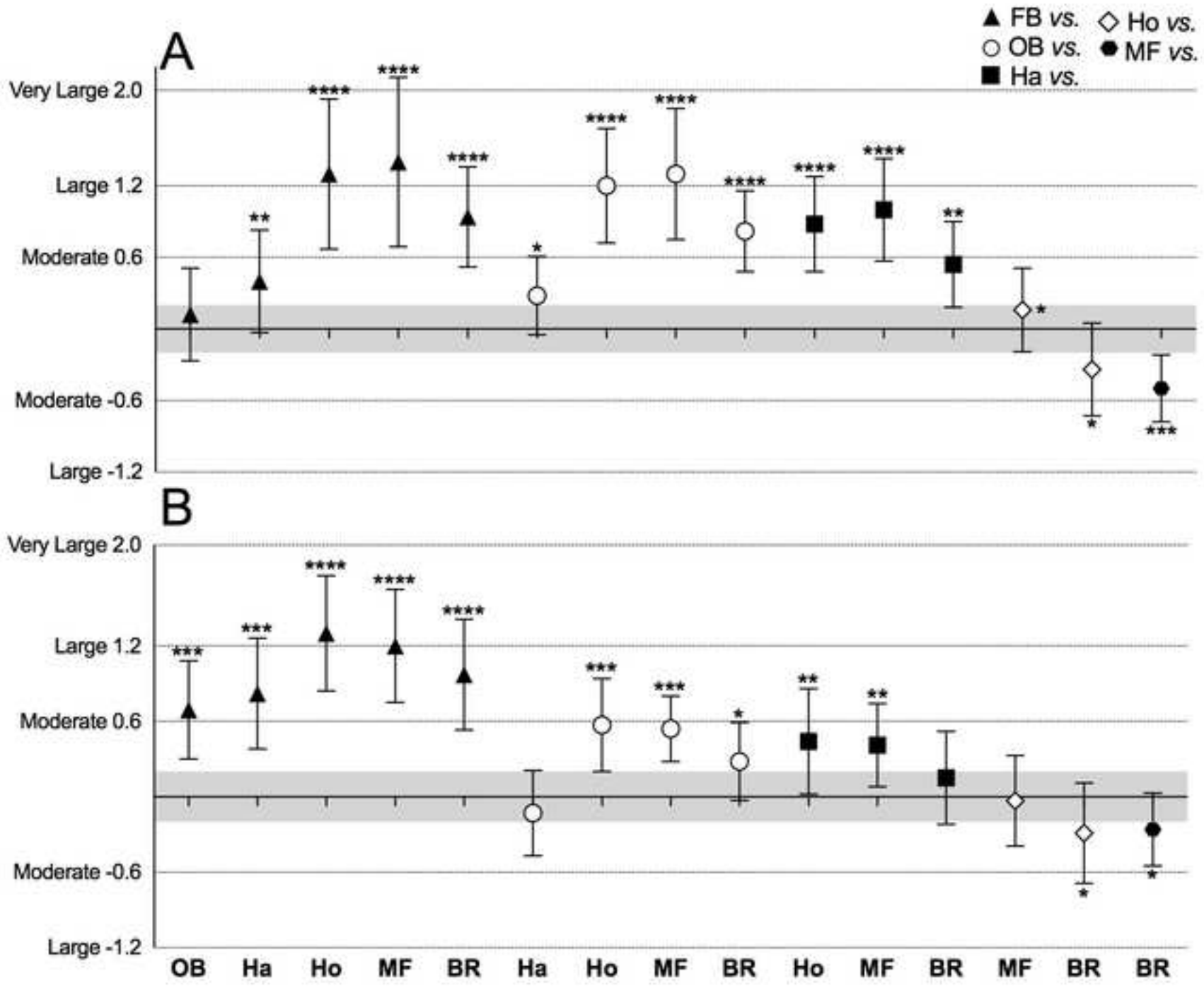

Figure 2